PATENT SPECIFICATION

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DRAWINGS ATTACHED

1 206 965

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(54) XEROGRAPHIC COPYING APPARATUS

(71) We, RANK XEROX LIMITED, of Rank Xerox House, 338 Euston Road, London, N.W.1, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In our co-pending Patent Application No. 45729/67 (Serial No. 1,206,964) from which this Specification is divided, there is described and claimed a xerographic copying machine having multiple object planes.

The present invention relates to apparatus for preventing sheets, especially paper sheets, from buckling for example when they are being fed into the copy tray of a copying machine.

According to the invention there is provided a sheet handling apparatus for preventing sheets from buckling while being transported in a partially unsupported condition comprising a transport means adapted to move a sheet along a predetermined path of travel, a member interposed in the path of travel of the sheet and positioned approximately midway across the width of the transport means, means to maintain the member in a position that extends into the path of travel whereby, as a sheet is transported past the member the sheet contacts the member and is depressed thereby at the area of contact therebetween, the member causes the transverse cross section of the sheet to be bowed, the member comprising an elongated finger having a biassing means associated therewith to maintain the member in a position wherein it extends into the path of travel of a sheet.

The invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a side view of the top of the paper transport and collecting tray of the copying machine described in co-pending Patent Application No. 45729/67 (Serial No. 1,206,964) mentioned above, with covers removed and showing a buckler finger according to one preferred form of the invention;

Figure 2 is a side view of an interposed finger in conjunction with a pair of pinch rollers;

Figure 3 is a side view of another interposed finger in conjunction with a pair of pinch rollers, and

Figure 4 is a front view of the transport apparatus of Figure 1.

Referring now to Figure 1 the paper feed mechanism used in the preferred embodiment of the invention is of the type disclosed in British Patent Specification No. 995,413. The sheet feeding mechanism of a xerographic copying machine positioned in the image transfer station, for seriatim feeding of cut sheet transfer material into contact with the xerographic drum so that the development powder images on the surface of said drum may be transferred to the transfer material, consists of a tray for holding a supply of cut sheet transfer material, separator rollers for separating a single sheet of transfer material from said supply, feed rollers for feeding a single sheet into impression contact with the drum and means for coordinating the operation of the separator rollers and feed rollers to thereby feed a single sheet of transfer material into contact with the drum for proper registration of the powder image on the drum onto the transfer material.

After the proper feeding of a sheet in registration with the image appearing on the drum, the sheet is transported by any suitable means, for example, a continuous belt, past a fuser wherein the powder image attached to the transfer sheet is fused thereon forming a permanent bond with the transfer material. The sheet is then carried by sets of pinch rollers such as set 30, in rotating touching contact with each other and guide plates such as plates 316, used to guide the lead edge of the transfer sheet to the next set of pinch rollers. The rollers are jour-

nalled in the frames 318, supporting the transport section of the apparatus and are free to rotate in a direction to carry the transfer material from the fuser section of the apparatus to the copy tray 320. The guide plates are formed to prevent buckling of the transfer sheet as it is pushed by the rollers into contact with the plates. The plates may be formed by stamping and have attached thereto, either as an integral part thereof or in some manner fastened thereon, brackets 322 which are screwed into the transport housing frames 318 by screws 324.

The last set of pinch rollers in the paper feed super structure 2 comprises a lower drive roller 326 formed of a metal shaft in a cylindrical shape appropriately attached to drive belts connected to a motor causing rotation of said lower drive pinch roller 326 in a counterclockwise motion as viewed from the right-hand side of the machine. The roller 326 is notched in several places along its axis, the notches placed around the circumference of the roller and normal to its axis (see Figure 4). Into these several notches are forced resilient O-rings 330. These O-rings maintain contact with last upper idler roller 332 driving said idler roller in a clockwise position, as viewed from the right-hand side of the machine, when lower roller 326 is driven. Roller 332 rests on the O-rings of roller 326 by the force of gravity due to its own weight.

A notch in approximately the centre of the lower roller 326 is formed generally in the same manner and to the same dimensions as the notches supporting the O-rings in the lower roller 326 but it not filled with an O-ring. Upper idler roller 332 is divided approximately at its centre and notched thereat. The shafts of the rollers 326 and 332 are positioned within frames 318 such that the central notches in roller 326 and roller 332 approximately coincide at the centre of the paper feed super structure 2, as well as the centre of both rollers. Fitted on a shaft 336 mounted to side frames 318 of the paper feed super structure is an interposed finger 338 which extends through the aperture formed at the centre of rollers 326 and 332 by the notched portions therein. The finger 338 is formed of a rigid, low friction material and is generally arcuate in shape extending from above the last sheet feed guide plate 340 through the aperture formed between rollers 326 and 332 to a position in front of and horizontally below the tangential plane of contact between the two last rollers.

There is a protrusion 342 appended to the finger 338 at its hinge 336 extending rearward therefrom within the super structure 346 (see Figure 1). Contacting the protrusion 342 is an adjustable spring arm 344 capable of exerting an upward force on the protrusion 342 (see Figure 1) which in turn operates on finger 338 as a level system the pivot point of which is at hinge 336. The force exerted causes the finger 338 to be biased downward toward roller 326 and below the tangent line which may be drawn through the contact points of the rollers 326 and 332 which would represent the path of a sheet travelling therethrough. The spring arm 344 is adjustable by moving clamp 348 relative to the spring arm pivot point 352 where the spring arm 344 is attached to the super structure 346. By moving the adjustment clamp 348 toward the pivot point 352 of the spring arm 344, and therefore, away from the hinge 356 and the protrusion 342, and the tension exerted by spring arm 344 on the protrusion 352 is reduced, thereby causing a lesser downward bias on the finger 338. Likewise, a movement of clamp 348 toward the hinge 336 will cause a greater downward force on the finger 338.

As a sheet, for example sheet 354, is transported through the superstructure 346 by the pinch rollers and guide plates positioned therein, it is brought to, and carried through, the rollers 326 and 332 until its lead edge contacts the lower arcuate surface of the finger 338. As the rollers continue to drive the sheet forward, the lead edge in contact with the finger 338 is depressed therebeneath and so remains throughout the drive thereunder. The passage of the sheet under the finger 338 causes an upward force on said finger and it is moved vertically upward to some extent, depending upon the bias put thereon, by protrusion 342 and spring arm 344. This bias may be adjusted by the adjusting clamp 348 so that the sheet 354 is depressed downward at its contact point with finger 338 to impart a sufficient force on the sheet to maintain it in a rigid state while it is expelled from the transport super structure 346. The force must not be so much as to crease the sheet along its line of contact with finger 338.

The stiffness required by a sheet of paper to prevent it from buckling may be discovered from the following formula:

$$\text{Stiffness} = \frac{ET^3}{12} \times \frac{W}{L^2}$$

where:

$$E = \text{Young's Modulus} = \frac{\text{Tensile stress}}{\text{Tensile strain}}$$

$$= \frac{\text{Force/area}}{\text{Change of length/original length}}$$

$$= \frac{\text{Force} \times \text{original length}}{\text{Area} \times \text{change of length}}, \text{ and}$$

T = effective thickness, i.e., dimension from uppermost segment to lowermost segment of cross-section; W = width of the sheet, and L = length. E would be affected by such external factors as the composition of the material of the sheet, the length of fibres, additives, moisture content, etc., of the sheet.

It is evidence that, for a uniform cross-section, T, W, and L have a definite relationship affecting the stiffness or anti-buckle capabilities of the sheet. Increase in length decreases the stiffness according to the second power, therefore, making it more difficult to prevent buckling as more of a sheet passes the pinch rollers 326 and 332. However, an exponential increase in stiffness may be imparted to the sheet by increasing the effective thickness T by including a deflection across the cross-section as is accomplished by this apparatus.

In order to achieve the desired deflection to increase T with different stocks of sheet material fed through the transport, it is necessary to adjust the force exerted by the finger 338 on the sheet 354. It is for this reason that an embodiment such as that shown in Figure 1 is beneficial in that the biasing force downward of the finger 338 is adjustable through spring 344. However, in some situations, such as may be found in copying machine apparatus, the variation in thickness or weight of stock being transported would not be great enough to necessitate a fully adjustable system. For this reason an anti-buckle apparatus such as that embodied in Figure 3 would be sufficient to achieve the desired results. Here the finger 338 is again pivotally fastened above the path of travel of a sheet which would be coincidental with the common tangent of roller 356 and O-ring 358, the latter being mounted on roller 360.

A downward bias is achieved on finger 338 by means of a protrusion 362 attached thereto and extending on the same side of an imaginary vertical line passed through pivot point 364 around which the finger 338 may vertically rotate. The protrusion 362 may be of a heavier material than the finger 338 or it may be formed of the same material but weighted in such a manner that it creates a moment arm in relation to the pivot point 364 forming a lever with point 364 as its fulcrum and exerting a downward force on the finger 338, such force directly related to its weight and the distance thereof from the fulcrum point. By pre-selecting the materials to be transported past a deflection finger one may determine the weight of the protrusion 362 which would most effectively operate in conjunction with the finger 338 to prevent buckling of the selected sheet material.

The surface of finger 338 which is contacted by the transported sheet should be a smooth, low friction surface formed not only to deflect the sheet as required for achieving the desired anti-buckle results but also to guide the sheet and prevent its catching on the finger and moving out of its predetermined path of rising along the lower surface toward the hinge for example.

The copy tray is back leaning in relation to the transport system. That is to say it is tilted from the horizontal rearward with its forward portion being at a point vertically higher than its most rear portion. The tilt is generally at 15° from the horizontal although this is not a limitation nor limiting feature. It is designed to have an angle with the horizontal approximately equal to the angle of the last flange 366 of the guide means 316 of the transport apparatus. Because the sheet emerges in a rigid state, due to the effect on it by the deflector finger 338, it maintains the same angle with the horizontal as the guide segment 366. Since this corresponds with the angle of the copy tray 320 to the horizontal, the sheet is presented parallel to the bottom of the copy holder tray and when released by the transport apparatus will fall onto the copy tray or the preceding sheet gathered thereon.

Figure 2 manifests a more simplified version of the deflector finger embodied in a transport apparatus super structure 346. The guide means and pinch rollers may be the same as those shown in Figure 1 including the set of final pinch rollers 332 and 326. Here, however, the deflector finger 368 is rigidly fastened to the super structure 346 at the top front portion thereof in a position in front of the final set of pinch rollers. The finger is positioned to interfere with the path of travel of the sheet being transported through the super structure and does not ride up as a sheet passes therebeneath, but is precisely positioned to maintain the exact deflection necessary to achieve the desired result of non-buckling of the sheet passing thereunder.

The amount of interference between the bottom portion of finger 368 and the path of travel of a sheet transported through the super structure is predetermined and pre-set by moving the fastening screw 370, and with it the finger 368, forward and back in relation to the pinch rollers 326 and 332 along an elongated slot 372 in the super structure 346. Once adjusted, the finger will so remain until a further external adjustment is made. If, however, the apparatus is used for a single stock of sheet material it would not be necessary to provide easily accessible adjustment means since a single setting will be all that is necessary to impart the proper deflection in the sheet to cause it to be rigid but not to crease under the force exerted by the deflection finger.

WHAT WE CLAIM IS:—

1. A sheet handling apparatus for pre-

venting sheets from buckling while being transported in a partially unsupported condition comprising a transport means adapted to move a sheet along a predetermined path of travel, a member interposed in the path of travel of the sheet and positioned approximately midway across the width of the transport means, means to maintain the member in a position that extends into the path of travel whereby, as a sheet is transported past the member the sheet contacts the member and is depressed thereby at the area of contact therebetween, the member causes the transverse section of the sheet to be bowed, the member comprising an elongated finger having a biasing means associated therewith to maintain the member in a position wherein it extends into the path of travel of a sheet.

2. Apparatus as claimed in claim 1 wherein the biasing means includes a spring in biasing contact with the member to exert a force in a direction opposite to that exerted on the member by a sheet passing in contact therewith, the force being sufficient to overcome the force exerted on the member by a sheet, whereby the member depresses the sheet in the area of contact.

3. Apparatus as claimed in claim 2 wherein the spring is a cantilever bar and has further associated therewith a movable fulcrum for varying its effective length and, therefore, the force it exerts on the member.

4. Apparatus as claimed in claim 1 wherein the biasing means includes a weighted arm intimately attached to the member, the weighted arm arranged to exert a force on the member in the same direction as the force of gravity exerts on said weighted arm whereby the weighted arm acts as a lever in relation to the member.

5. Apparatus as claimed in any one of claims 1 to 4 wherein the transport means has associated therewith a sheet receptacle, the receptacle tilting rearward toward the transport means from the horizontal.

6. Apparatus as claimed in any one of claims 1 to 5 wherein the transport means includes at least one pair of pinch rollers and the member is positioned in the path of travel developed by the pinch rollers such that it contacts a sheet travelling along the path of travel.

7. Apparatus as claimed in any one of claims 1 to 6 wherein the means to maintain the member in a position that extends into the path of travel includes means to pivotally mount the member to extend into the path of travel of a sheet whereby the member moves about its pivot axis as a sheet passes into operable contact with the member.

8. Apparatus as claimed in any one of claims 1 to 6 wherein the member is mounted above the path of travel of a sheet and extends through the path of travel being moved toward said biassing means by the sheet as it passes therebeneath contacting the surface of the member.

9. A sheet handling apparatus for preventing sheets from buckling while being transported in a partially unsupported condition substantially as herein described with reference to the accompanying drawings.

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ERRATUM

SPECIFICATION NO. 1,206,965

Page 1, Heading, Index at acceptance *after* "6Y" *insert* "B8R"

THE PATENT OFFICE
21 October 1970

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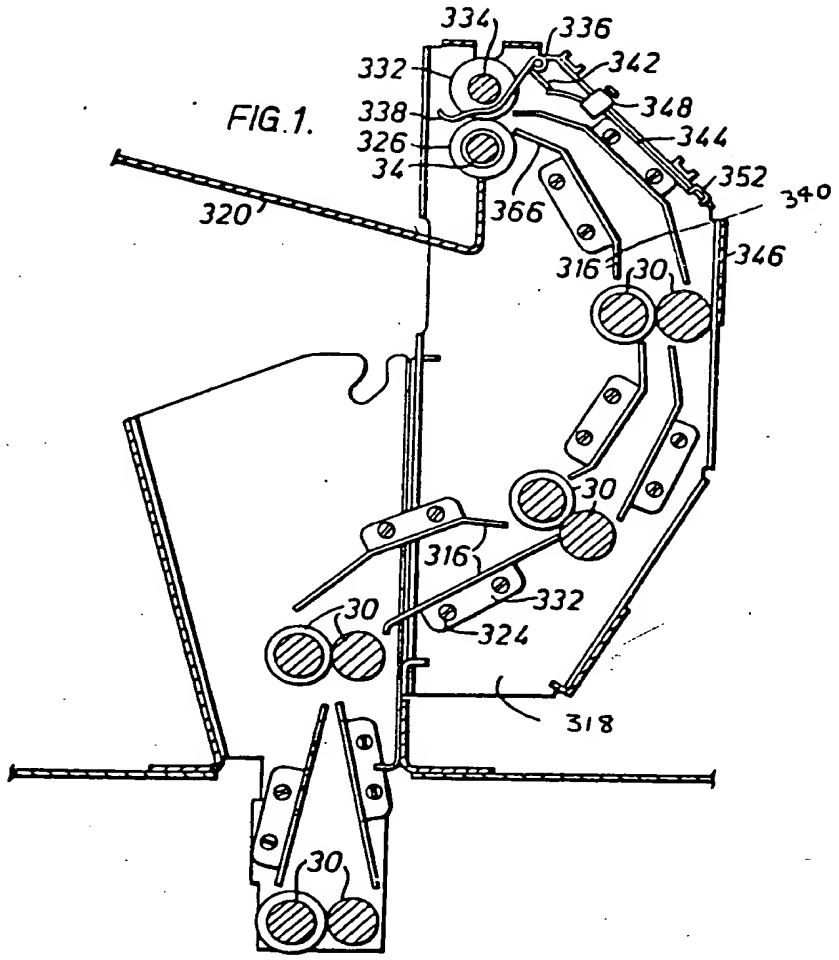
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

FIG.1.



1206965 COMPLETE SPECIFICATION
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Sheet 2

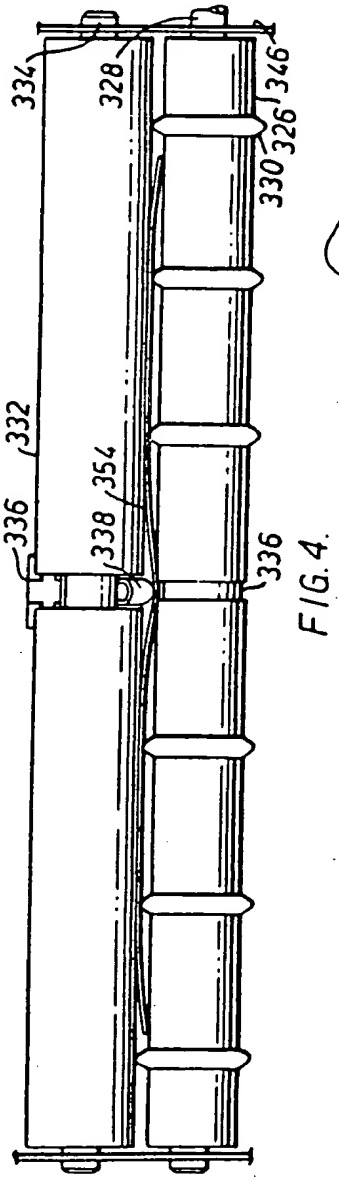

FIG. 4.

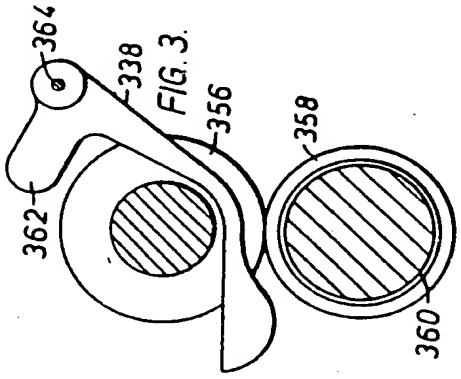

FIG. 3.

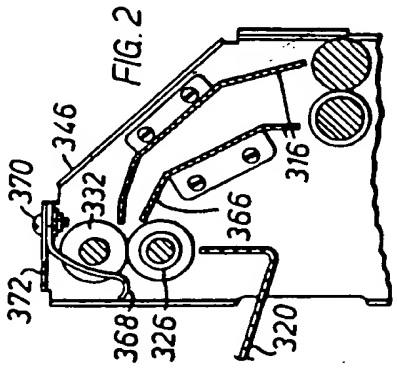

FIG. 2